PATENT SPECIFICATION (11) 1 495 728

1 495 728

(21) Application No. 52053/74 (22) Filed 2 Dec. 1974 (19)

(31) Convention Application No. 421 846 (32) Filed 5 Dec. 1973 in

(33) United States of America (US)

(44) Complete Specification published 21 Dec. 1977

(51) INT. CL.[2] A61C 5/00

(52) Index at acceptance

A5R 75B

(54) METHOD AND APPARATUS FOR RESTORING BADLY DISCOLORED OR FRACTURED INVOLVED TEETH

(71) I, FRANK ROLAND FAUNCE, a citizen of the United States of America, of 405 Scotts Way, Augusta, Georgia, United States of America, do hereby declare the

invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to both cosmetic and structural restoration of teeth such as teeth that are badly discolored or teeth that have been fractured. More particularly, the invention relates to restoration of teeth by means of an overlay where a desirably colored preformed facing of fully polymerized plastics material may be bonded to the enamel of the tooth to provide teeth of pleasing cosmetic appearance or to provide a fully restored properly shaped and properly colored tooth restoration. The invention also relates to support means for pontics in dental bridgework and for splinting of periodonically involved teeth.

Many phenomenon occur that have the adverse effect of causing teeth to become badly discolored and in many cases, teeth of children or adults become discolored during the formative period or later. Some of the causes of tooth discoloration are pharmaceutical discoloration that occurs when children are required to take certain drugs. Certain drugs have been known to cause the teeth of children to have various shades of yellow or brown if such drugs are taken before the permanent teeth of a child erupt. Discoloration also occurs due to the diet of persons that live in certain parts of the world, largely due to the minerals that are ingested along with the water that is consumed. The dental patient may also have a hyperplastic condition where the enamel of the teeth does not fully develop, causing the teeth to become easily discolored. A hyperplastic condition may also be evident, where the teeth of the patient may have an excess of mineral salt deposit that causes the teeth of the patient to have white spots. (Metatbolic diseases such as those releasing bile pigments or hemorrhagic disturbances that release blood pigments may cause a discoloration of teeth. Bacteria frequently cause staining of teeth, e.g., green stain or tobacco stain).

Thus far, there has been no effective method of treating discolored teeth in order to give them a pleasing cosmetic appearance. In the past, the only effective way the cosmetic appearance of teeth could be improved was for the teeth to be capped with plastics or porcelain crowns. This is a very expensive and time consuming procedure and the costs involved have the effect of eliminating cosmetic capping for all but a few patients. Cosmetic inlays have also been employed in the past but the difficulty of bonding materials to the enamel of teeth effectively prevents this procedure from being commercially feasible in the practice of dentistry.

When teeth become fractured or cariously involved, it frequently becomes necessary to restore the teeth to their proper shape and appearance to promote proper incisive and masticatory function and for cosmetic purposes. If a tooth has become fractured and restoration is desirable, in the past restoration has been accomplished by application of crowns to the teeth, which crowns have been composed of metal materials, such as gold, and plastics materials, such as methyl methacrylate polymer. An acceptable restoration has been accomplished in the past by application of jacket crowns to the teeth and by application of porcelain that is fused to gold crowns. These crowns typically involve a great deal of expense and also involve a great deal of dental chair time for application. For example, restoration of teeth by application of gold crowns may cost, at the present time, in the order of $200 to $225 and may require as much as three hours chair time in order to complete the installation of each crown.

A primary disadvantage in the application of crown restorations to teeth is the requirement that the tooth be pre-shaped to a

drastic degree in order that the crown may be properly applied thereto. For proper application of crowns it is necessary that the crown and the tooth be prepared in order to achieve retention of the crown. The crown, in a proper application, is retained in position on the tooth by proper fitting to provide retention, and the presence of crown cement between the prepared tooth and the crown is primarily for the purpose of filling any voids that might exist and thereby prevent debris from becoming deposited in the voids between the crown and the prepared tooth. The cement disposed between the crown and the tooth, although providing a gripping function to some degree, does not provide the primary gripping function that retains the crown in physical assembly with a tooth structure. One reason for this is the fact that cements that have been used in the past for cementing crowns to prepared teeth, during crown restoration of the teeth, are water soluble materials and in time, if a crack or fissure is present between the tooth and the crown, saliva will penetrate the joint between the crown and the tooth and dissolve the cement. If proper retention were not provided between the crown and the tooth, the crown would become separated quite readily from the tooth structure.

A more recently utilized method of tooth restoration is effective in restoration of fractured teeth as well as teeth that have developed caries. After etching of the teeth with an acid solution, such as 50% to 75% phosphoric acid or citric acid for a short period of time, for the purpose of removing mineral salts from the enamel surface and creating spaces or "micro pores" in the enamel where the mineral salts have been dissolved by the acid, a dental sealant material may be applied to the acid-prepared enamel surface which sealant enters the micro pores and when polymerized, forms an intimate mechanical bond with the enamel surface of the tooth. The dental sealer material may be of the type that is produced by the reaction product of Bisphenol A and Glycidyl Methacrylate such as a product manufactured and sold under the trademark of Nuva-Seal by the Caulk Division of Dentsply International, Inc. of Millford, Delaware. The sealant product, referred to as "Nuva-Seal", is activated by Benzoin methyl ether catalyst prior to application thereof to a tooth surface and is polymerized after application to the surface by exposure to ultra-violet light.

After application of the sealant material to the prepared enamel surface of the tooth, a dental filler material may be applied to the prepared and sealed surface and may be shaped essentially to the original configuration of the tooth with a shaping instrument. The dental filler material may also be of a type that is based upon the reaction product of Misphenol A and Glycidyl Methacrylate which is also activated by Benzoin methyl ether catalyst and selectively polymerized by exposure to ultra-violet light. A dental filler material that is suitable for this purpose is sold by the Caulk Division of Dentsply International, Inc. under the trademark "Nuva-Fil". This material will not become polymerized until it is selectively exposed to ultra-violet light. The material, therefore, may be worked for whatever period of time is necessary to properly shape the tooth restoration to its desired physical characteristics and polymerization will occur a few seconds after application of ultra-violet light to the shaped material. After the dental filler material has been shaped and polymerized, the outer surface of the filler material and a portion of the exposed enamel at the marginal portions of the filler material may be finally shaped with appropriate sanding or grinding instruments and a coating of dental sealer material may be then applied to desirable portions of the restored tooth and may be subsequently polymerized by application of ultra-violet light.

Although excellent tooth restorations may be accomplished by the above noted use of ultra-violet light polymerized dental sealer and filler material, it is very difficult to achieve precise color matching of the restored tooth to the color of adjacent teeth. The restoration process therefore is often less than desirable from aesthetic standpoint. The dental filler and sealer material is commercially produced in a few different shades in order that color matching may be accomplished as nearly as possible, but it is well known that wide variation in color and tooth appearance is found in the teeth of dental patients. It is virtually impossible to select from the few shades of materials that are available a material that is capable of precisely matching with the color and appearance of adjacent tooth if color matching is indeed desirable.

In many cases, it is not desirable to match the tooth restoration material with the adjacent teeth, especially when the patients natural teeth have become discolored to the point that the cosmetic appearance is undesirable.

In the event one or more teeth should be missing, it is typically necessary to employ a dental bridge wherein a dental prothesis is connected to teeth adjacent the opening produced by the missing tooth and an artificial tooth or pontic forming a part of the prothesis is supported in the space to prevent migration of the adjacent teeth. In view of the fact that bridge work may not be supported by the enamel of abut-

ment teeth adjacent an opening it is typically necessary to provide the adjacent teeth with crown restorations even though these teeth may be perfectly normal. The crowns may be provided with appropriate means for physical attachment of the bridge work in order to support the bridge work prothesis. It is, of course, undesirable to provide crown restorations for perfectly normal teeth, although in some cases this is necessary to avoid the problems that may occur by migration of teeth by absence of one or more of the patients' permanent teeth. It is desirable, therefore, to provide the abutment teeth adjacent an opening caused by a missing tooth or teeth with means for positively securing a prothesis bridge work in place without necessitating the tooth preparation that is necessitated by application of bridge work support crowns.

It is therefore an object of the present invention to provide an improved method of providing teeth of a patient with an overlay for the purpose of providing a pleasing cosmetic appearance to the teeth.

The present invention provides a tooth facing formed of dental restoration material and adapted to be bonded to the enamel surface of a patient's natural tooth to provide a restorative covering for the labial proximal and incisal surfaces of the patient's tooth, said facing comprising a shaped single opaque layer of dental restoration plastics material having a substantially uniform thickness, said layer being formed to define a concave surface that conforms generally to the configuration of portions of the natural tooth to which it is to be bonded and to define at least one surface adapted to conform to the configuration of the outer enamel surface of said tooth, said layer having knife edges for engagement with the enamel surface of said tooth, said layer being of such color as to provide a pleasing cosmetic appearance.

In a facing as set forth in the last preceding paragraph preferably said layer of tooth restoration plastics material is flexible and readily conforms to desired portions of the enamel surface of the tooth being restored.

In a facing as set forth in the last preceding paragraph but one preferably said layer of tooth restoration plastics material is adapted to cover substantially all of the labial surface of the tooth to which it is to be bonded, at least some of the edges being tapered to define the knife edges that engage the enamel surface of said tooth; and the facing further comprising a portion integral with said layer that corrects any tooth deformity and restores the tooth to the normal configuration thereof.

In a facing as set forth in the last preceding paragraph preferably said body of plastics material includes at least one lingual portion integral with said layer and adapted for bonding to the enamel surface of said tooth to be restored at at least one of the lingual edges of said tooth.

The present invention further provides a tooth restoration element adapted to be bonded to the enamel surface of at least one of a patient's teeth, said tooth restoration element comprising: a pair of facings as set forth in any one of the last four immediately preceding paragraphs and adapted to be bonded to the laabial surfaces of teeth disposed on either side of a tooth space created by a missing tooth or teeth; and a pontic connected to each of said facings for support by said facings within said space.

In an element as set forth in the last preceding paragraph preferably said pontic is formed integrally with said facings.

The present invention further provides a tooth restoration element adapted to be bonded to the enamel surface of at least one of a patient's teeth, said tooth restoration element comprising: at least two facings as set forth in any one of the last four immediately preceding paragraphs but two and adapted to be bonded to the labial surfaces of adjacent teeth, said facings being disposed in rigid assembly for securing a plurality of teeth to be periodontically splinted in rigid relationship.

The present invention further provides a method of restoring teeth of a patient that have become badly discolored, fractured or have been treated for caries, said method comprising the steps of: etching appropriate portions of the enamel of the teeth of the patient with an acid solution to provide surface irregularities in the enamel; providing a facing according to the invention for each tooth to be restored, which facing conforms to the configuration of the surfaces of the tooth to be restored; disposing between the etched surface of the enamel of the tooth and the facing a quantity of curable bonding agent; applying mechanical pressure to the facing to expel excess bonding agent from between the facing and the etched surface of the enamel; forming a small quantity of bonding agent about the joint established between the marginal edges of the facing and the enamel surface of the tooth; allowing the bonding agent to cure in place; and finishing the exterior surface of the tooth restoration thus formed to yield a smooth exterior tooth restoration surface.

A method as set forth in the last preceding paragraph may further include the steps of: coating the etched surfaces of each tooth and the interior surfaces of each facing with dental sealant and allowing the sealant to harden; and disposing a quantity of dental filler material between the hardened coated surfaces of each tooth and its

facing and allowing the dental filler material to harden in place.

In carrying out a method as set forth in either one of the last two immediately preceding paragraphs preferably said bonding agent comprises: a bonding agent that is produced by the reaction product of Bisphenol A and Glycidyl Methacrylate, said bonding agent being activated by Bensoin methyl ether and becoming polymerized following exposure to ultra-violet light.

Alternatively said bonding agent comprises: a two-part bonding agent that polymerizes within a predetermined period of time after said two parts are mixed.

A method as set forth in any one of the last four preceding paragraphs may comprise the further steps of applying a coating of dental coating material to the exterior of said facing, said coating covering the joint between the marginal edges of said facings and the coated enamel surface of said tooth; and allowing said coating to harden.

Preferably said dental coating material is polymerized in place following application thereof.

Preferably said denttal filler material is polymerized in place following application thereof.

Preferably said dental sealant material and said dental filler material are produced by the reaction product of Bisphenol A and Glycidyl Methacrylate, said dental sealant and dental filler materials being activated by Bensoin methyl ether and becoming polymerized following exposure to ultra-violet light.

Preferably said facing is formed of flexible plastics material and said method includes: forming said facing to the external configuration of selected surface areas of said tooth prior to allowing said dental filler material to harden, whereby said facing will retain its formed configuration in addition to becoming bonded to the structure of the tooth.

A preferred embodiment of the present invention may conveniently take the form of a method and materials for restoring badly discolored or fractured teeth or teeth from which caries have been removed, wherein the method includes selection of a shaped fully-polymerized plastics facing that may be composed of a suitable plastics material and which may be selected according to color and physical appearance in order to provide teeth of pleasing aesthetic appearance. The shaped facing may be further modified by shaping or grinding in order to fit the configuration of the tooth being restored as precisely as possible. After the color, shape and physical characteristics of the tooth have been matched as desired and after the facing has been preshaped to fit the tooth being restored, the enamel surface of the tooth to be restored may be etched with an acid material, such as a solution of 75% phosphoric acid, for a sufficient period of time to prepare the appropriate enamel surface of the tooth for reception of a dental sealant material that may be polymerized in place. The inside surface of a plastics facing to be secured to the tooth to be restored may also be coated with a thin coating of the same dental sealant material which material may be polymerized in any suitable manner. A coating of a dental filler material that may be subsequently polymerized may then be applied to the tooth to be restored or to the facing to be bonded to the tooth and the facing may be applied to the tooth in such manner as to squeeze out any excess dental filler material, thus filling all of the voids between the tooth and the facing with the filler material. A small amount of the dental filler material existing at the marginal edges of the facing may be smoothed about the marginal edges in order to provide a smooth contour at the joint between the edges of the facing and the enamel surface of the tooth. After inspection of the tooth to insure that the color and physical characteristics of the facing exactly match the color and physical characteristics of adjacent teeth, the filler material may be selectively polymerized in place, where it is rendered from a paste or putty-like consistency to a hard porcelain-like durable consistency. The dental sealant material and the dental filler material may both be composed of a compound that will remain unpolymerized or uncured for a relatively indefinite period of time and which may be subsequently polymerized in a few seconds by application of ultra-violet light thereto. The dental filler material may also be of the type that is premixed prior to application thereof to the teeth of the patient and which is allowed to become polymerized in place following a predetermined curing period.

So that the manner in which the features, advantages and objects of the present invention are attained and can be understood in detail, more particularly description of the invention, briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

It is to be noted however that the appended drawings illustrate only typical tooth restorations that are made possible by employment of the method and materials set forth herein and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

In the Drawings:

Fig. 1 is a side elevational view of an anterior tooth having a portion of the enamel

thereof shown in section and showing a preformed plastic facing that has been applied to the labial and incisal portions of the tooth in accordance with the present method.

Figs. 2a—2c are illustrations of some of the various tooth restorations that are possible through employment of the present invention.

Fig. 3 is a view of the upper teeth of a patient and shows a dental bridge prothesis and lamina preparation of teeth that support the bridge prosthesis in operative position.

Fig. 4 is a partial elevational view of the bridge work prothesis illustrated in Fig. 3 illustrating the outward appearance of a completed bridge installation.

Fig. 5 is a view of the upper incisor teeth of a patient illustrating periodontal splinting of the patient's teeth.

Now referred to the drawings and firstly to Fig. 1 a tooth structure is illustrated generally at 10, which tooth is an anterior incisor having a fractured incisal portion. The exposed crown portion 12 of the tooth is shown as having a laminar plastics restoration applied thereto which laminar restoration also includes a lower incisal portion to restore the fracture of the tooth. A portion of the root 14 of the tooth is shown positioned relative to gum tissue 16 surrounded thereabout.

Assuming that the tooth 10 has a fractured incisal portion as shown and perhaps that the labial surface of the enamel is badly discolored, according to the method of the present invention, a restoration technique may be employed wherein a shaped plastics facing 18 may be bonded to the enamel portion 20 of the tooth structure. It is not necessary, as in the past, to grind away the tooth structure and expose the dentin shown in broken line at 22 unless the presence of caries necessitates such activity. In fact, it is not necessary to remove any major portion of the tooth structure to achieve complete restoration of the tooth.

It may be desirable to prepare a very small portion of the exposed surface of the enamel in order to remove undesirable mineral deposits that might interfere with the bonding process. This may be accomplished by very light sanding. Desired portions of the exposed enamel then may be prepared for bonding by application of a suitable acid material for a short period of time. This is known as acid etching, a process that creates spaces or "micropores" within the surface layer of enamel which will allow a dental sealant material to penetrate into the surface of the enamel itself and establish an efficient mechanical interlocking bond with the enamel. As the tooth is etched, projections, which may be referred to as "rods" or "tags" are developed which increase the physical bonding of the sealant to the tooth structure. The employment of acidic conditoning agents has an effect on the tooth enamel that removes at least a portion of the mineral salts from the enamel surface to a very shallow depth, i.e., in the order of 25 microns, thereby creating spaces or micropores in the enamel where the mineral salts have been dissolved. Etching of the tooth enamel, although initially creating a dull appearance on the enamel surface does not constitute permanent alteration of the enamel surface of the tooth. In fact, areas of enamel surface that are etched, if not covered by a coating of dental sealant material, will return to normal translucency within a few days. It is theorized that acid-etched enamel is remineralized by the deposition of calcium phosphate salts from the saliva. Other than the creation of a superficial etch, there appears to be no detrimental effect to the tooth tissue.

After acid-etching of desirable portions of the enamel of the tooth, the acid-etched enamel is maintained clear of any material such as water, oil, saliva that might interfere with the bonding process and a dental sealant material is applied thereto and is allowed to subsequently become polymerized in place in order to seal the micropores that have been established by the etching process and to establish the physical surface to which a plastics facing may be effectively bonded. Although the dental sealant material may take any suitable form within the scope of the present invention, it may be desirable to employ a dental sealant material such as that sold under the trademark Nuva-Seal by the Caulk Division of Dentsply International, Inc., mentioned hereinabove, and referred to hereinafter merely as sealant. The sealant is a very "wet" material that will readily penetrate the minute interstices or micropores that are developed on the enamel surface during the etching process. After application of the sealant coating 24 to the prepared surface portions of the tooth enamel, a coating 26 of similar sealant material may be applied to the inside surface portion of the facing 18. The surface coatings of both the tooth and the facing may be then polymerized, which in the case of Nuva-Seal dental sealant is accomplished by means of exposure to ultra-violet light after having been previously activated by Beinzoin methyl ether catalyst in the manner discussed above.

After the coatings 24 and 26 of the enamel and facing, respectively, have become polymerized, hardening the sealant material to a porcelain-like quality, a quantity 28 of a dental filler material may be applied either to the facing 18 or to the coating 24 of the tooth enamel and the facing may be brought into intimate contact with the tooth struc-

ture. It is desirable that the dental filler material be capable of controlled polymerization or curing in order that it may be inspected for physical shape and cosmetic appearance and approved before it is permanently bonded to the tooth structure. If during inspection, it is found that the facing 18 is of undesirable color characteristics and does not precisely match with adjacent teeth or with exposed portions of the tooth being restored, it will be desirable to simply remove the preformed facing and substitute a facing of proper color and shape. Ordinarily, the facing material will be emplaced prior to application of coatings to the tooth structure in order that the color characteristics of the facing may be precisely matched with adjacent teeth.

After the facing has bene installed in proper position, it is tightly pressed to the tooth structure and excessive dental filler material is squeezed out about the marginal edges of the facing material. All of the voids between the external tooth structure and the internal surface of the facing material will be filled with the dental filler material thereby establishing proper structural integrity of the restoration. Most of the excessive filler material that has been squeezed from between the tooth and facing is removed and a small portion of the filler material may be molded about the joint established between the marginal edge of the facing material and the adjacent enamel portion of the tooth. After this has been done and the physical shape of the restoration has been approved, the dental filler material may be polymerized, thereby causing it to harden to a very hard porcelain-like characteristic.

Following polymerization of the dental filler material, the facing and the tooth enamel surface adjacent the marginal edges of the facing may be sanded or ground lightly in order to ensure a smooth and continuous restored tooth surface. Restoration then may be completed by application of a coating of dental sealant material to the exposed surfaces of the facing and the tooth enamel adjacent the marginal edges of the facing. The outer coating 30 of dental sealant material then may be polymerized in any suitable manner thereby achieving a completed restoration having the glossy outer appearance of the natural enamel surface of the restored tooth and having color characteristics that precisely correspond to the color characteristics of adjacent teeth.

If either the filler or sealant materials are premixed and become polymerized after a predetermined limit period of time, it will be necessary of course, to insure that the tooth facing is properly colored, is properly emplaced and shaped before the curing or polymerization period ends.

The facing that is to be applied to the teeth during restoration according to the method set forth herein may conveniently take any suitable form that is suitable for tooth restoration. It has been found through initial tests that a plastics material such as fully polymerized, preformed methyl methacrylate is a suitable material for tooth restoration ni accordance with the teachings of the present invention. Methyl methacrylate is utilized presently in the manufacture of denture teeth and therefore corresponds very closely to the appearance and functional capabilities of natural teeth. It is envisaged that the facings be premanufactured according to various shapes, forms, colors, contour and the type of restoration desired. Facings may also be provided for restoration of teeth after treatment to remove proximal caries. The marginal edges of the facings are of knife-edged configurations in order to establish a smooth contiguous surface of the joint between the enamel and the facing.

The plastics facings, if desired, may be composed of very thin and flexible material that may be readily pressed into shape by application of mechanical pressure thereby causing the flexible facing to conform to the tooth surface that is to be restored. For example, a thin and flexible facing may cover the labial surface of the tooth and may cover one or more of the proximal edges. After applying the bonding agent to the tooth surface or to the facing, the facing may simply be emplaced on the tooth. The bonding agent may then be selectively polymerized by application of ultra-violet light or by any other suitable means to achieve a proper bond between the facing and the tooth. Also, if desired, the facing and the etched surface of the tooth may be provided with a thin coating of dental sealant that is allowed to harden in place either responsive to application of ultra-violet light or by any other suitable means of activation.

With reference now to Figs. 3 and 4, in accordance with the teachings of the present invention, simple and efficient bridge work may be accomplished without necessitating provision of abutment crowns on abutment teeth adjacent a missing tooth opening within which a pontic is to be disposed. As illustrated in Fig. 3, a number of permanent teeth of a patient are depicted pictorially and a pontic 34 is substituted for a missing natural tooth. The pontic 34 is shown to be disposed between teeth 36 and 38. As was mentioned hereinabove, ordinarily it is necessary, in order to support the pontic 34 in place between the teeth, to provide the teeth with bridge support crowns. In order to accomplish this, the teeth 36 and 38 were ordinarily reshaped by grinding to prepare the teeth for reception of abutment crowns

and, of course, such reshaping permanently distorts the normal configuration of the teeth.

In accordance with the present invention, it is not necessary to reshape the abutment teeth 36 and 38 or make impressions, it being only necessary to prepare the anterior enamel surface of the adjacent teeth for efficient bonding of bridge support facings thereto. In accordance with the present invention, the pontic 34 will be formed integrally with, or connected to, support facings 40 and 42, the inner surface of which may be prepared in the same manner as discussed above in connection with preparation of the facing 18 depicted in Fig. 1.

After application and polymerization of the coating of sealant to both the inside surfaces of the facings 40 and 42, the labial surfaces of the teeth 36 and 38 may be etched with a solution of phosphoric acid or with any other suitable etching material that provides a microporous enamel surface on the teeth. A coating of dental sealant may then be applied to teeth and may be subsequently polymerized. Dental filler material then may be applied either to the inside surfaces of the support facings 40 and 42 or to the prepared and coated labial surfaces of the teeth 36 and 38 and the pontic may then be positioned by positioning of the facings 40 and 42 into intimate engaging assembly with the prepared surfaces of the teeth 36 and 38. Sufficient pressure is then applied to the facings 40 and 42 to squeeze out excess dental filler material. A portion of the excess dental material is then molded about the joint created between the marginal edges of the respective facings and the prepared and coated enamel surfaces of the teeth to provide a smooth contiguous surface at the joint.

After the pontic and the facings have been emplaced in the manner illustrated in Figs. 3 and 4, the bridge work will have its final appearance and can be inspected both by the patient and by the dentist for determination if the appearance is cosmetically pleasing. After acceptance, the dental filler material then may be selectively polymerized in any suitable manner, such as by application of ultra-violet light, for example, thereby completing the bond between the facing and the tooth and ensuring that all voids that might exist between the facing and the adjacent teeth are completely filled with dental filler material. After hardening of the dental filler material, portions of the teeth, facings and perhaps also the pontic may be lightly sanded or abraded with pumice to eliminate any irregularities in the exposed surfaces of the facings, the teeth and the pontic and to prepare these surfaces for a coating of dental sealant material that is subsequently applied. The dental sealer material, after being applied will have a very glossy finish and when subsequently polymerized, such as by application of ultra-violet light thereto, will provide a bridge work that conforms as precisely as possible to the appearance of the patient's other teeth, if in fact such conformance is indeed desirable. Where the remaining teeth of the patient are discolored or have bene treated to remove caries, it may be appropriate to also provide certain ones of the patient's teeth with facings as discussed above in connection with Fig. 1 for enhancing the cosmetic appearance of the patient's teeth.

Referring particularly to Fig. 4, the pontic 34 will be physically connected or formed integrally with the adjacent facings 36 and 38 at the typical tooth contact areas 44 and 46. The anterior portions of the pontic and the adjacent facings will be of such configuration that the appearance of tooth separation will be given. The anterior facing and pontic structure will make effective use of shadows to enhance the appearance of tooth separation and embrasures 48 and 50 will appear between the facings and pontic and below the gum line 52. The bridge work prothesis, therefore, will have a natural appearance and it will not be necessary to modify the teeth by crowning in order to provide proper support for the pontic. If it subsequently becomes desirable to remove the pontic, this may be done very simply and efficiently and the teeth 36 and 38 may, if desired, be returned to the original condition thereof simply by effective removal of the facing material therefrom. If desired, the facing material may simply be removed by grinding and polishing thereby exposing the original enamel surface of the teeth.

With reference now to Fig. 5, it may be desirable to establish periodontic splinting between one or more teeth, if a tooth needs to be physically supported by another tooth. Ordinarly, when periodontically involved teeth are splinted together, it is necessary to provide both of the teeth with appropriate splinting crowns and to secure the crowns together by appropriate bonding or by other physical means. Fig. 5 discloses a pair of teeth that have been splinted together by means of facings that are either integrally formed or bonded together at the contact points of the teeth. Here again, the facings and the teeth to be splinted will be prepared by acid etching and coating in the same manner as discussed above in connection with Fig. 1. The facings 54 and 56, which are joined together at the contact point 58, are applied to the teeth with dental filler material and dental sealant in the same manner as discussed above. The material from which the facings are composed may be appropriately colored to match the adjacent

teeth or may be colored as desired for pleasing cosmetic appearance. Moreover, it is not necessary to grind away the major portion of each of the teeth in order to provide splinting crowns that will secure the teeth together. In the event it is subsequently desirable to eliminate the physical support between the teeth it may be simply necessary to separate them at the contact points or in the alternative, the facing material may be removed from the teeth in any suitable manner thereby exposing the original enamel surface of the teeth.

Figs. 2a, 2b and 2c illustrate a few of the many possible tooth restorations that are possible according to the teachings of the present invention. For example, in Fig. 2a the tooth has a fractured incisal edge, as shown in broken line. The facing applied to the labial surface of the tooth would therefore be provided with a labial portion covering the labial surface of the tooth and a relatively thick incisal portion would be formed integrally with the thin labial portion.

Fig. 2b depicts a tooth wherein the facing includes a pair of proximal portions and an incisal portion formed integrally with a thin labial portion Fig. 2c illustrates a tooth in side view, being provided with a facing having a proximal edge portion.

It is practical to assume that cosmetic facings may become unsatisfactory in appearance or function after a period of effective use. It is also logical to assume that in a small number of cases the facings may become chipped, broken, worn or detached and may need replacement. When replacement is necessary, it is simply appropriate to restore the tooth involved to the original form thereof by removal of the facing and thereby exposing the original enamel surface of the tooth. The process for installation of cosmetic facings may simply be repeated without any structural damage to the tooth that is treated in this manner. It may be desirable to remove only part of the facing to accomplish restoration because a plastics-to-plastics bond may be readily accomplished. Restoration of fractured, or badly discolored teeth may be accomplished at minimal cost through employment of low cost materials and through conservation of dental chair time for such treatment. Through employment of the invention in practice, dental bridge work and splinting of teeth may also be effectively accomplished at very low cost. Moreover, it will not be necessary to alter abutment teeth or to provide crowns for periodontic splinting because the facing material itself will be of sufficient structural integrity for support of pontics and for the establishment of supporting connections between splinted teeth. One of the most important aspects of the present invention is the fact that there is no need whatever for permanently altering the physical structure of teeth either for the accomplishment of cosmetic facing or for preparation of support crowns as in the case of bridge work or periodontic splinting and the teeth may be returned to their original conditon simply by removal of the facing material therefrom.

Where the teeth of a patient have become severely discolored or treated for caries such as frequently occurs when a patient lives in certain parts of the world, the teeth can be treated very simply and efficiently and at minimum cost in order to provide the teeth with a pleasing cosmetic appearance. During the process of installation of facings for cosmetic appearance, after the facings have been attached to the teeth and before the bonding material has become polymerized, the facings may be inspected for cosmetic appearance and if unacceptable, may be simply and efficiently removed and other facings may be substituted therefor. The facings both for cosmetic improvement of the teeth and for restoration of fractures or deformation resulting from treatment of caries may be readily accomplished without necessitating the use of anesthesia to prepare the patient for treatment.

It is therefore apparent that the present invention is one well adapted to attain all of the objects and advantages hereinabove set forth, together with other advantages which will become obvious and inherent from a description of the method and materials utilized according to the teachings of the invention.

WHAT WE CLAIM IS:—

1. A tooth facing formed of dental restoration material and adapted to be bonded to the enamel surface of a patient's natural tooth to provide a restorative covering for the labial, proximal and incisal surfaces of the patient's tooth, said facing comprising a shaped single opaque layer of preformed dental restoration plastics material having a substantially uniform thickness, said layer being formed to define a concave surface that conforms generally to the configuration of portions of the natural tooth to which it is to be bonded and to define at least one surface adapted to conform to the configuration of the outer enamel surface of said tooth, said layer having knife edges for engagement with the enamel surface of said tooth, said layer being of such color as to provide a pleasing cosmetic appearance.

2. A tooth facing according to claim 1, wherein: said layer of tooth restoration plastics material is flexible and readily conforms to desired portions of the enamel surface of the tooth being restored.

3. A tooth facing according to claim 1 wherein: said layer of tooth restoration

plastics material is adapted to cover substantially all of the labial surface of the tooth to which it is to be bonded, at least some of the edges being tapered to define the knife edges that engage the enamel surface of said tooth; and the facing further comprising a portion integral with said layer that corrects any tooth deformity and restores the tooth to the normal configuration thereof.

4. A tooth facing according to claim 3, wherein said body of plastics material includes: at least one lingual portion integral with said layer and adapted for bonding to the enamel surface of said tooth to be restored at at least one of the lingual edges of said tooth.

5. A tooth restoration element adapted to be bonded to the enamel surface of at least one of a patient's teeth, said tooth restoration element comprising: a pair of facings according to any one of the preceding claims adapted to be bonded to the labial surfaces of teeth disposed on either side of a tooth space created by a missing tooth of teeth; and a pontic connected to each of said facings for support by said facings withing said space.

6. A tooth restoration element according to claim 5, wherein: said pontic is formed integrally with said facings.

7. A tooth restoration element adapted to be bonded to the enamel surface of at least two of a patient's teeth, said tooth restoration element comprising: at least two facings according to any one of claims 1 to 4 and adapted to be bonded to the labial surfaces of adjacent teeth, said facings being disposed in rigid assembly for securing a plurality of teeth to be periodontically splinted in rigid relationship.

8. A method of restoring teeth of a patient that have become badly discolored, fractured or have been treated for caries, said method comprising the steps of: etching appropriate portions of the enamel of the teeth of the patient with an acid solution to provide surface irregularities in the enamel; providing a facing according to claim 1 for each tooth to be restored, which facing conforms to the configuration of the surfaces of the tooth to be restored; disposing between the etched surface of the enamel of the tooth and the facing a quantity of curable bonding agent; applying mechanical pressure to the facing to expel excess bonding agent from between the facing and the etched surface of the enamel; forming a small quantity of bonding agent about the joint established between the marginal edges of the facing and the enamel surface of the tooth; allowing the bonding agent to cure in place; and finishing the exterior surface of the tooth restoration thus formed to yield a smooth exterior tooth resteration surface.

9. A method of restoring teeth according to claim 8, including the steps of: coating the etched surfaces of each tooth and the interior surfaces of each facing with dental sealant and allowing the sealant to harden; and disposing a quantity of dental filler material between the hardened coated surfaces of each tooth and its facing and allowing the dental filler material to harden in place.

10. A method of restoring teeth according to either one of claims 8 and 9, wherein: said bonding agent comprises a bonding agent that is produced by the reacttion product of Bisphenol A and Glycidyl Methacrylate, said bonding agent being activated by Bensoin methyl ether and becoming polymerized following exposure to ultra-violet light.

11. A method of restoring teeth according to either one of claims 8 and 9 wherein said bonding agent comprises: a two-part bonding agent that polymerizes within a predetermined period of time after said two parts are mixed.

12. A method of restoring teeth according to any one of claims 8 to 11 comprising the further steps of: applying a coating of dental coating material to the exterior of said facing, said coating covering the joint between the marginal edges of said facing and the coated enamel surface of said tooth; and allowing said coating to harden.

13. A method of tooth restoration according to claim 12, wherein: said dental coating material is polymerized in place following application thereof.

14. A method of tooth restoration according to either one of claims 12 and 13 wherein: said dental filler material is polymerized in place following application thereof.

15. A method according to any one of claims 12 to 14, wherein; said dental sealant material and said dental filler material are produced by the reaction product of Bisphenol A and Glycidyl Methacrylate, said dental sealant and dental filler materials being activated by Benzoin methyl ether and becoming polymerized following exposure to ultra-violet light.

16. A method according to any one of claims 12 to 15, wherein said facing is formed of flexible plastics material and said method includes: forming said facing to the external configuration of selected surface areas of said tooth prior to allowing said dental filler material to harden, whereby said facing will retain its formed configuration in addition to becoming bonded to the structure of the tooth.

17. A tooth facing substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

18. A tooth restoration element substantially as hereinbefore described with re-

ference to Figures 3 and 4 or Figure 5 of the accompanying drawings.

19. A method of restoring teeth substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

20. A method of restoring teeth substantially as hereinbefore described with reference to Figures 3 and 4 or Figure 5 of the accompanying drawings.

ERIC POTTER & CLARKSON,
Chartered Patent Agents,
5, Market Way, Broad Street,
Reading RG1 2BN.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1977.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1495728 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG.1

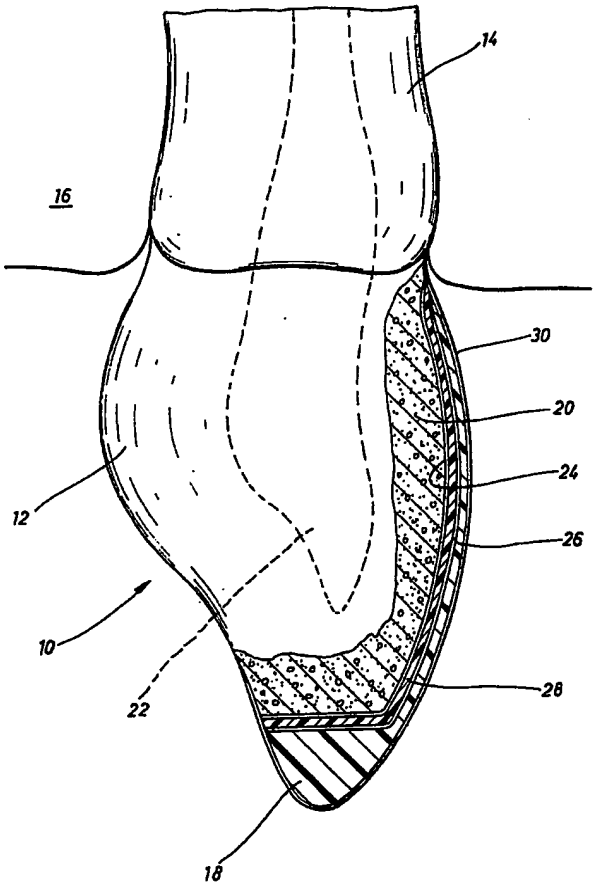

FIG.2a FIG.2b FIG.2c

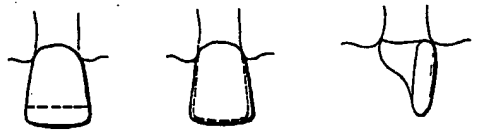

FIG.3

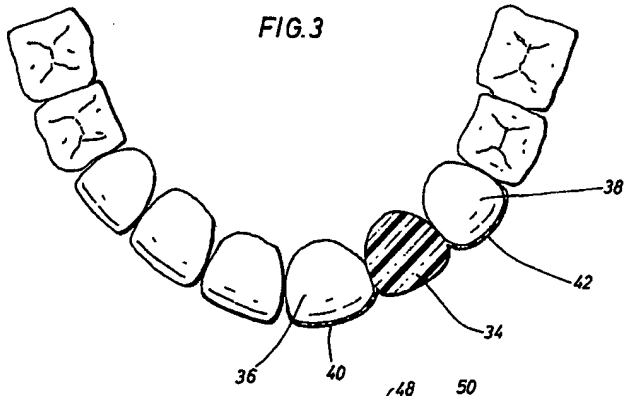

FIG.4

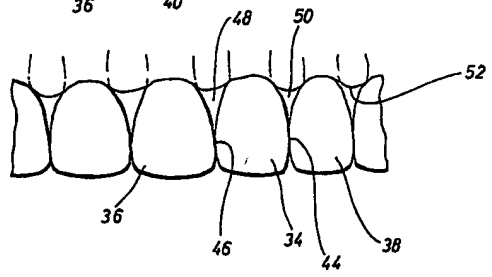

FIG.5